

Social Networks & Network Structures

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Social Network Analysis

Social Network Analysis [SNA] is the collection, mapping and measurement of relationships and flows among persons, groups, organizations, technologies or other information processing entities

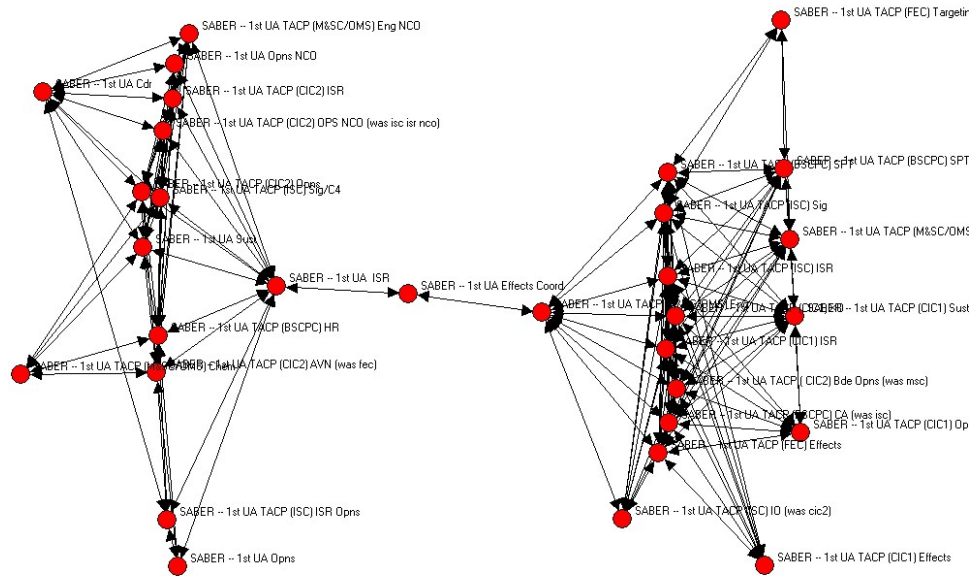
What is a social network?

Nodes (●)

- **People**
- **Units of action**
- **Coalition partners**
- **Departments**
- **Resources, assets**
- **Ideas, Skills, or
Assertions**
- **Events**
- **Nation-states**
- **Computer Servers**

Relations Between Nodes (—)

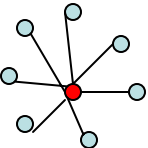
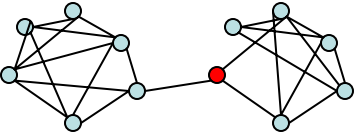
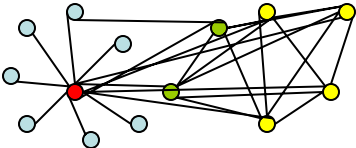
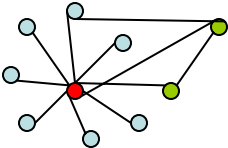
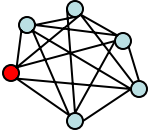
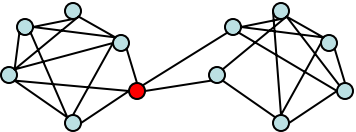
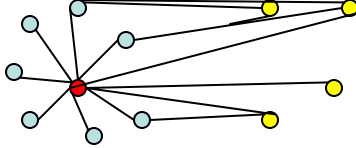
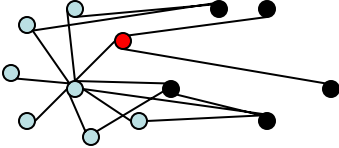
- **Who do you like or respect?**
- **Transfer of resources, information, money**
- **Authority lines**
- **Association or affiliation**
- **Alliance**
- **Alternative resource**



Sampling of Empirical Topics

- **Workflow and hierarchy**
- **Network organizations (adaptable organizational designs)**
- **Actor (human node) similarity**
- **Physical and temporal proximity**
- **Personality**
- **Attitude similarity**
- **Job satisfaction and commitment**
- **Turnover**
- **Power, influence and leadership**
- **Job acquisition and promotion**
- **Social capital**
- **Individual and group performance**
- **Conflict and unethical behavior**
- **Creativity and innovation**
- **Diffusion of information and innovation**
- **Knowledge management**
- **Wealth distribution**
- **Epidemics**
- **Terrorist networks**
- **Scale-free networks/power laws**
- **Internet**

Individual network position

<p>Degree Centrality in the know</p> 	<p>High Betweenness connects groups</p> 	<p>Cognitive Demand emergent leader</p> 	<p>Task exclusivity critical ability</p> 
<p>Eigenvector central core</p> 	<p>Closeness shortest paths</p> 	<p>Resource exclusivity mobilize resources</p> 	<p>Knowledge exclusivity Mobilize info</p> 

● Person with high measure value

● Person

● Task

● Resource

● Knowledge

Who to target (vulnerabilities)

- **Centralities (Communication)**
 - Degree – most connected
 - Betweenness – most paths
- **Exclusivities (Expertise)**
 - Knowledge – special expertise
 - Task – special experience
- **Demands/Loads (Role)**
 - Cognitive demand – emergent leader
 - Workload
 - High Shared Situation Awareness

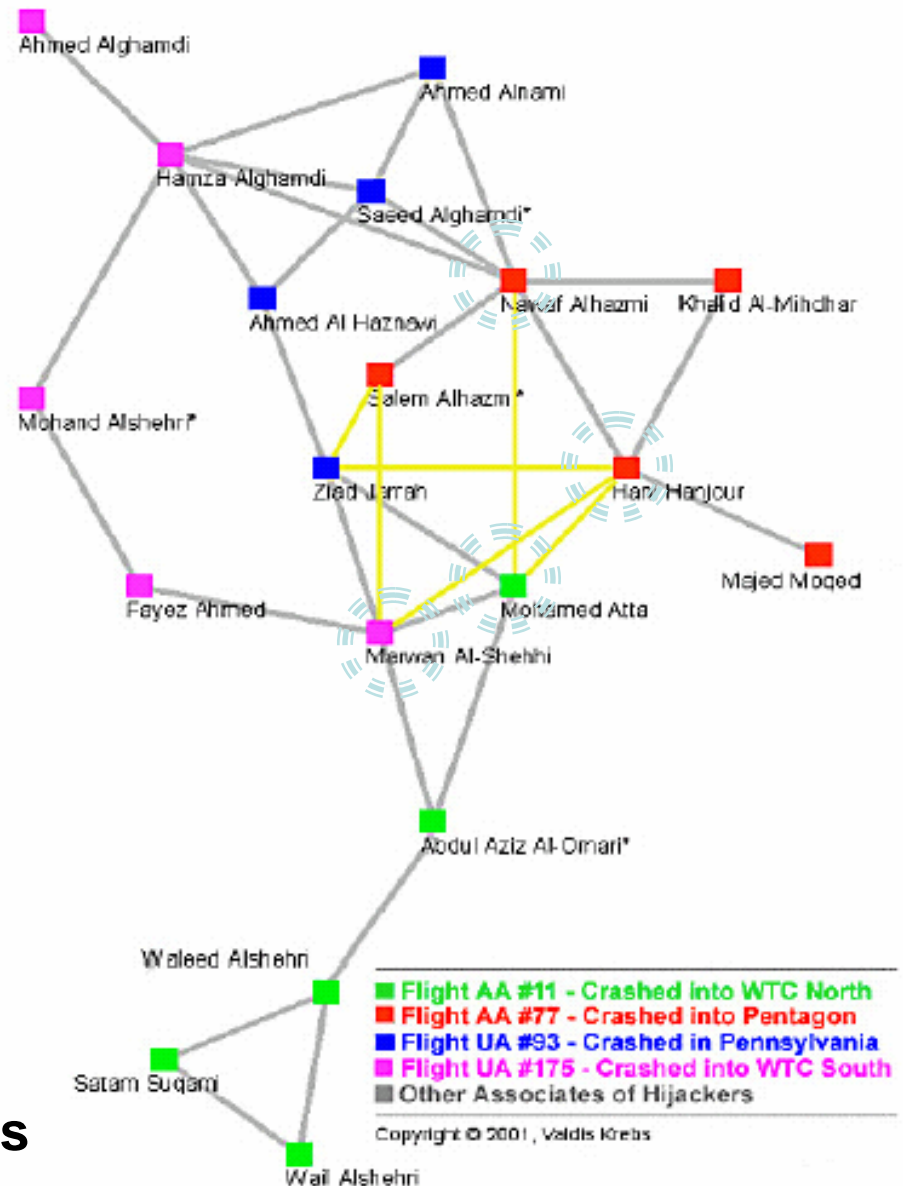


Figure 3 Trusted Prior Contacts + Meeting Ties [shortcuts]

Recent Research in Command & Control

- **Latent Semantic Analysis**
 - Team communication
 - Emergent team dynamics
 - Shared situation awareness
- **Dynamic Network Analysis**
 - Organizational structure
 - Shared situation awareness
 - Organizational performance

Social Networks

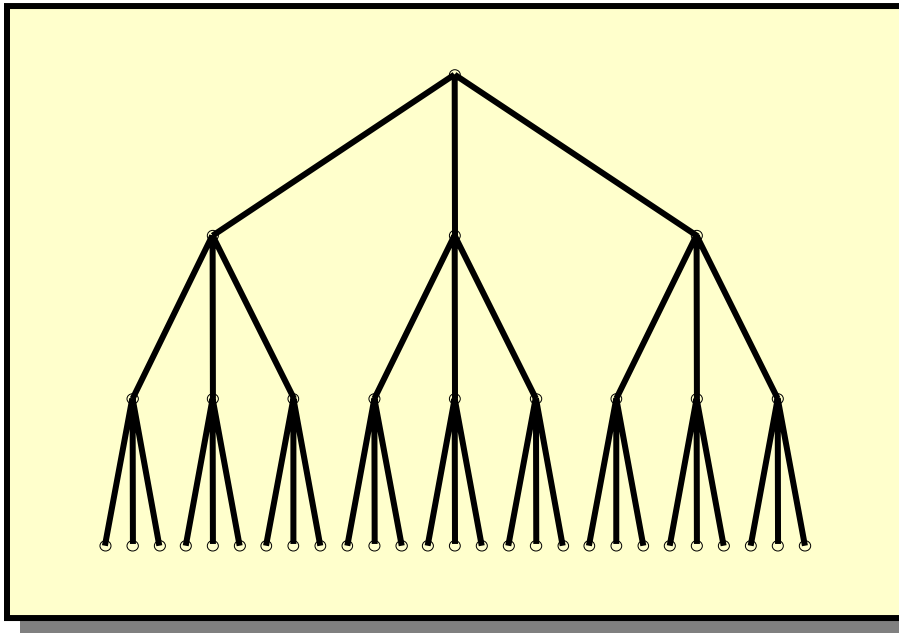
Research Challenges§

- **Large-scale networks**
 - Experiments
 - Measures
 - Modeling and analysis
 - Dynamics
 - Incomplete, incorrect data
- **Topology**
 - Relationship between architecture and function/behavior
 - Organizational design
- **Process/Dynamics**
 - Network formation and change
 - Information propagation/processing
 - Robustness and security
- **Real-time Feedback**
 - Dynamic decision-making
 - Self-adaptation

§ *Network Science*, National Academies Press, Washington, D.C., 2005

Network Structures

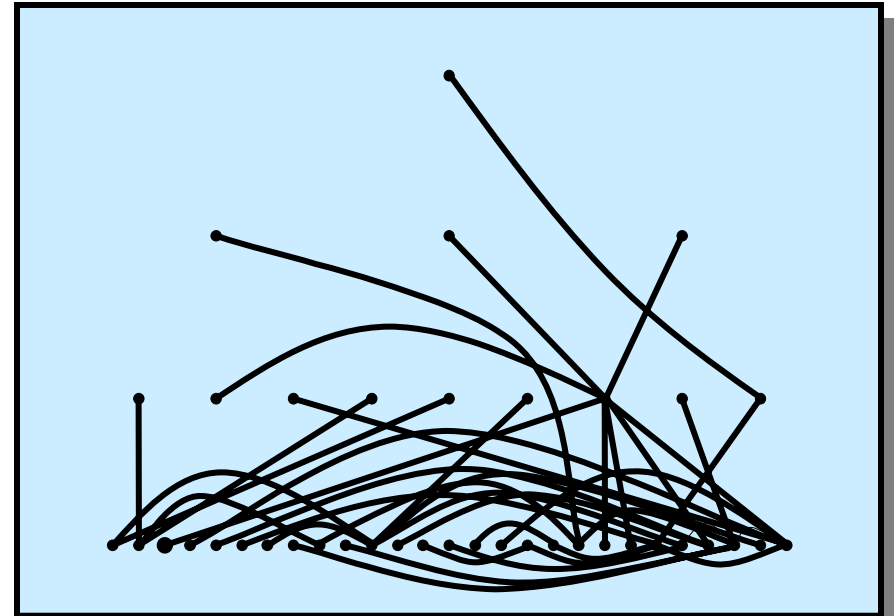
Chains *versus* Networks



Chain

Too brittle, simple pattern, simple control, scaled

“business end” most poorly connected, hard to reconfigure or change flow

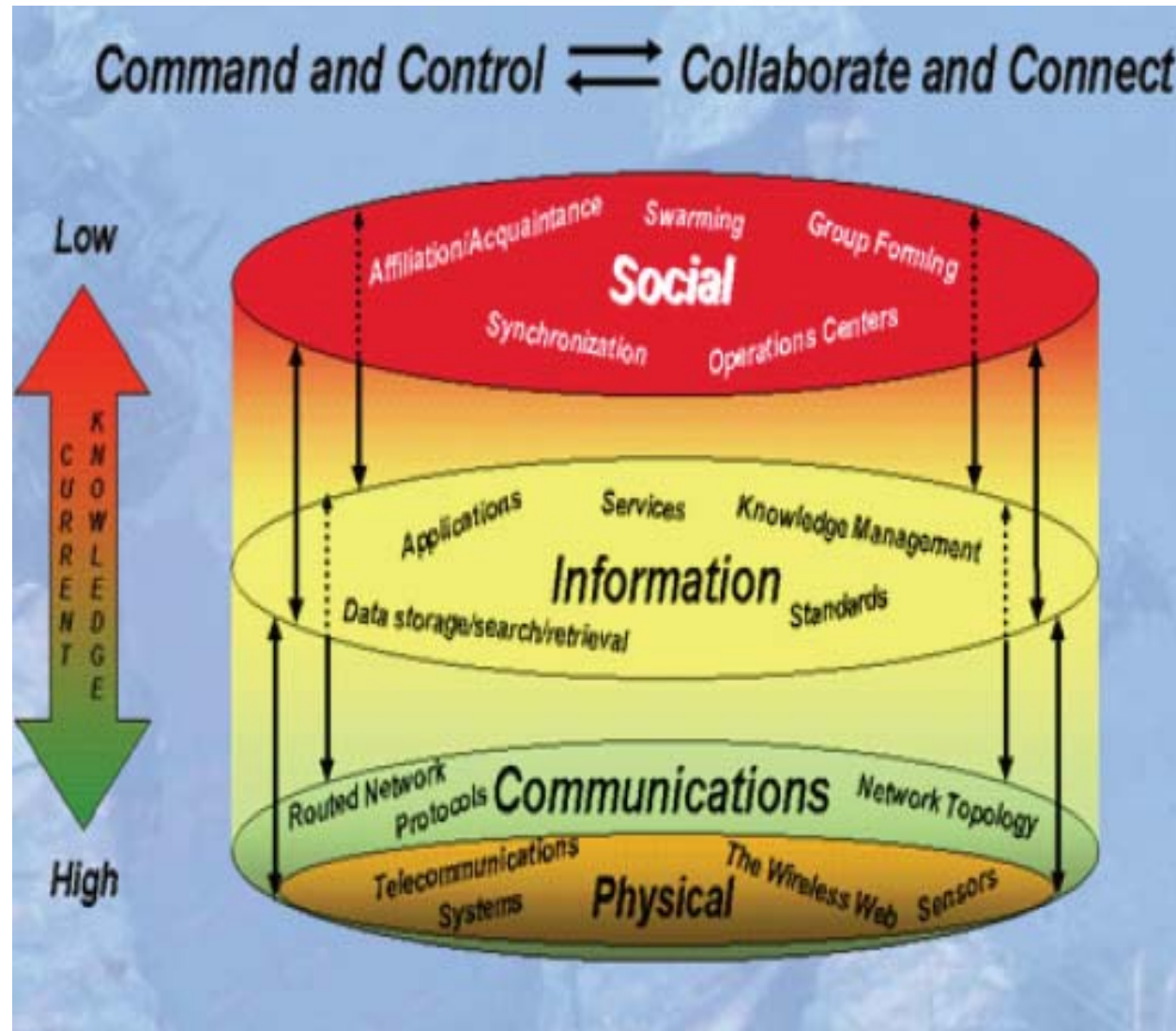


Network

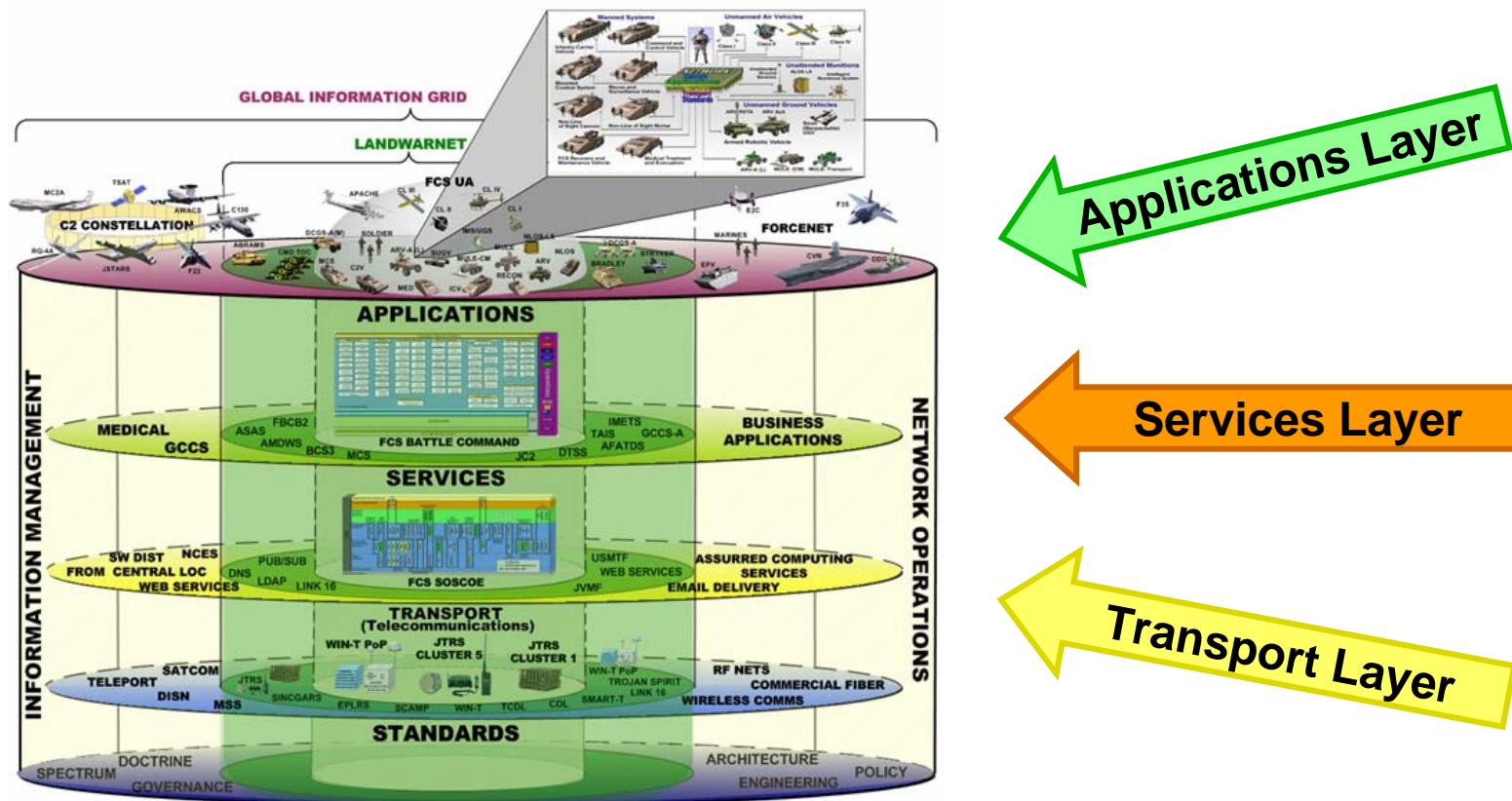
Very robust, complex pattern, complex control, scale free

“business end” best connected, natural to reconfigure or change flow

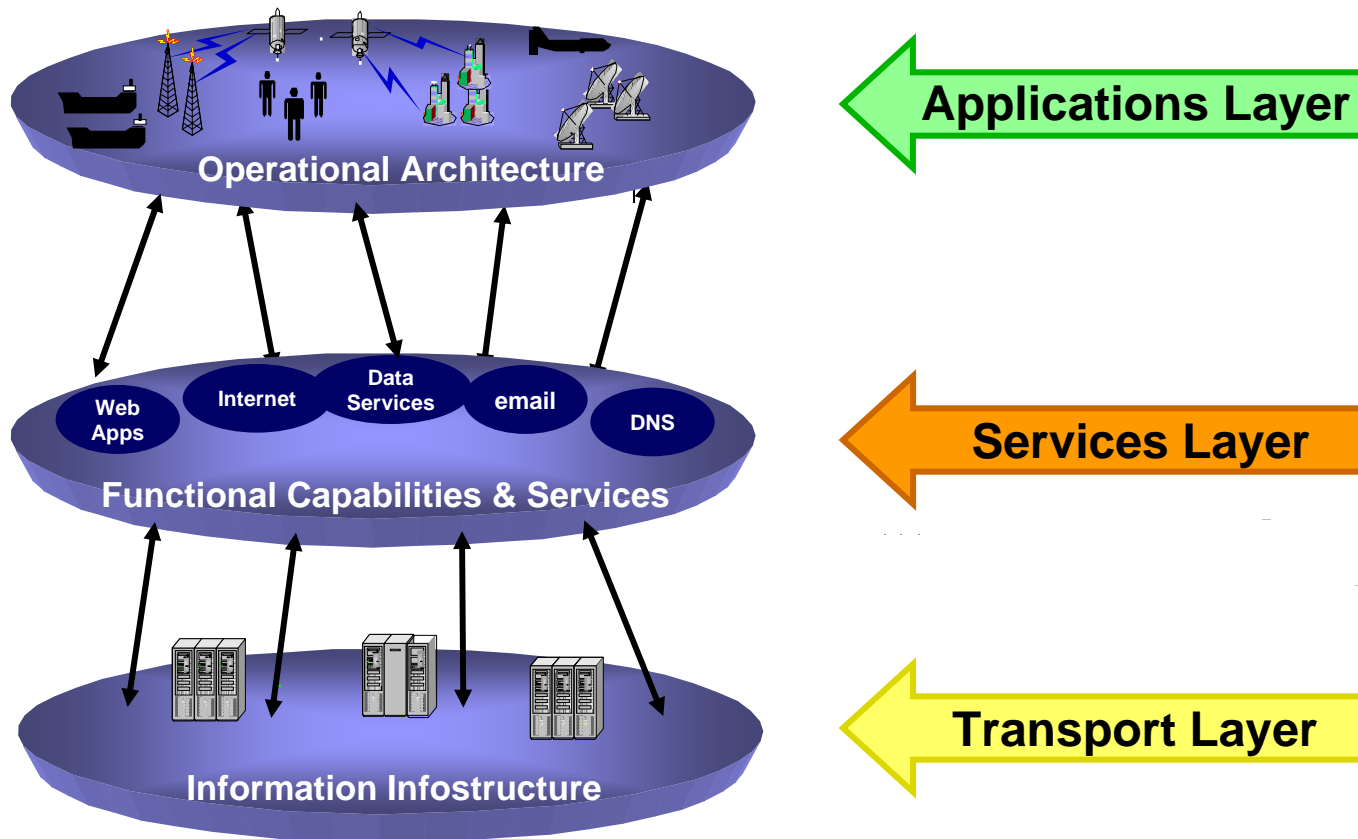
A Network Framework



The FCS BCT Integrates With Army Enterprise System Into the GIG



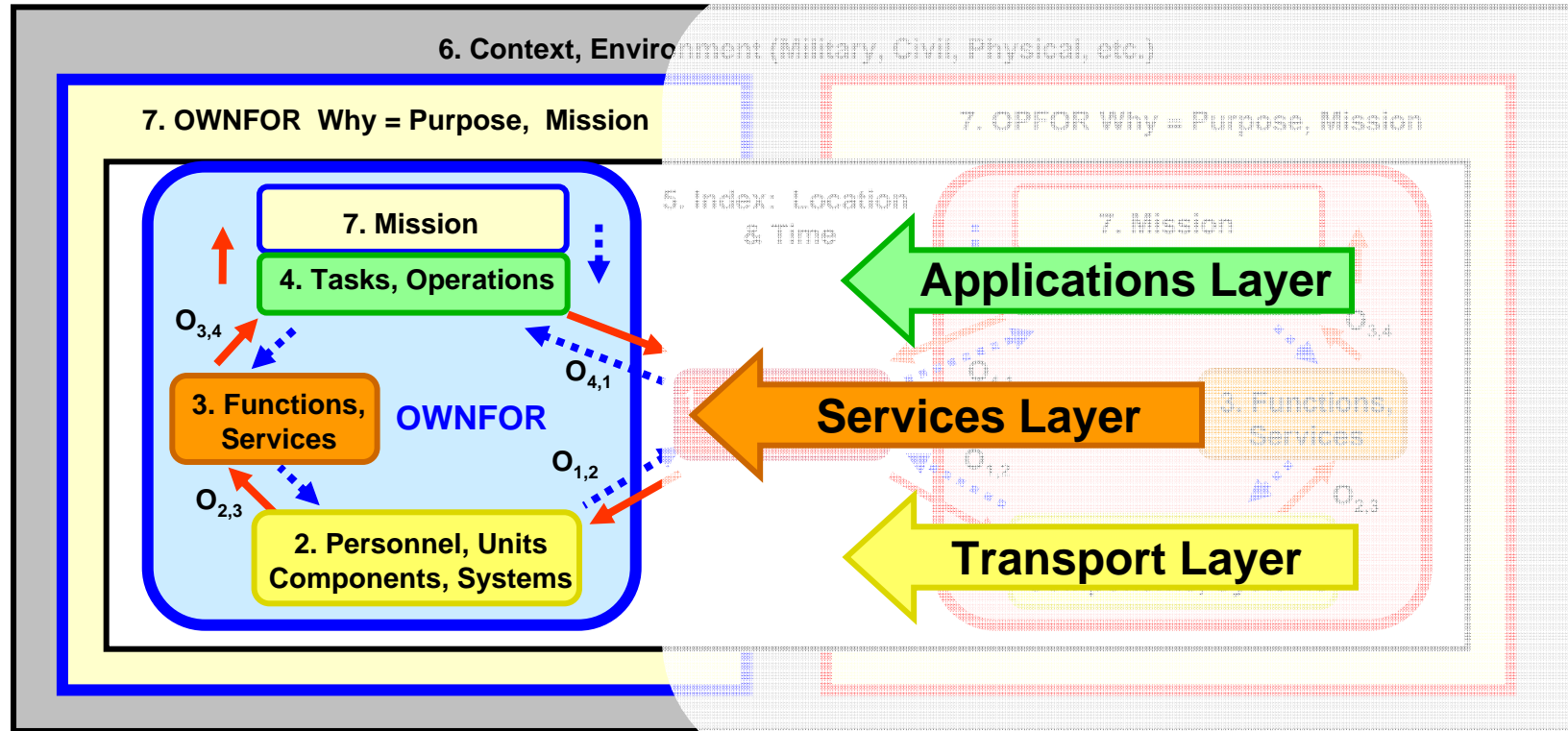
a-MINDTM§ - Automated Mission Relevant Situational Awareness



a-MIND Technology automates dependency understanding enabling analysis of Mission Impact of Infostructure Disruptions

§ Mission Impact Management (MIM) Solution a Product of Northrop Grumman- Patent Pending

Missions and Means Framework



- A way to reason about forces, materiel, and other resources in context of operational missions, their purposes, and desired end states
- Builds on standard best practices (e.g., MDMP, METL Development)
- Explicitly links requirements and solutions

End

Missions and Means Framework vice DoD

Architecture Framework Products:

MMF Levels

- **Level 7: Purpose Mission OV-1 AV-1**
The Why and Wherefore An assignment with a purpose that indicates the action to be taken.
What the required outcomes are and “who” has been assigned them
- **Level 6: Environment Context AV-1**
Under what Circumstances a mission is to be accomplished
- **Level 5: Index Location/Time OV-1 AV-1**
Where (geo-spatial) and When with what TPFDD execution matrix
- **Level 4: Tasks Operations OV-5**
Task-based, outcome-centric specification of Operations that provide the Means to accomplish the Mission. Objective: Organize Task outcomes, Evaluate Mission Effectiveness
- **Level 3: Functions Capabilities OV-5 SV-11**
Function-based, performance-centric How Well specifications of Capabilities.
- **Level 2: Components Forces OV-2 OV-3 OV-4 All SV**
Component-based, state-centric specifications of the Forces that provide the Means. Network of Units, Personnel, and Equipment. Physical and Logical networking
- **Level 1: Interactions Effects OV-6a,OV-6b,OV-6c,OV-7 SV-10a,SV-10b,SV-10c**
Interaction-based, Phenomena-centric Specification of Effects of Operations on Forces

Missions and Means Framework vice DoD

Architecture Framework Products:

MMF Operators

- **Level 7: Purpose Mission OV-1 AV-1**

The Why and Wherefore. An assignment with a purpose that indicates the action to be taken. What the required outcomes are and Who has been assigned them

- **Level 6: Environment Context AV-1**

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Interaction-based, Phenomena-centric Specification of Effects of Operations on Forces

Social Networks

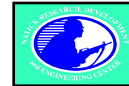
Some Common Network Properties

- Individual Network Position
 - Centrality
 - Structural hole
 - Strong vs. Weak ties
- Topology
 - Experimental
 - Circle, Star, Chain, Y
 - Real Organization
 - Hierarchy, Network organization

Human Dimension: Connections to the Broader Community

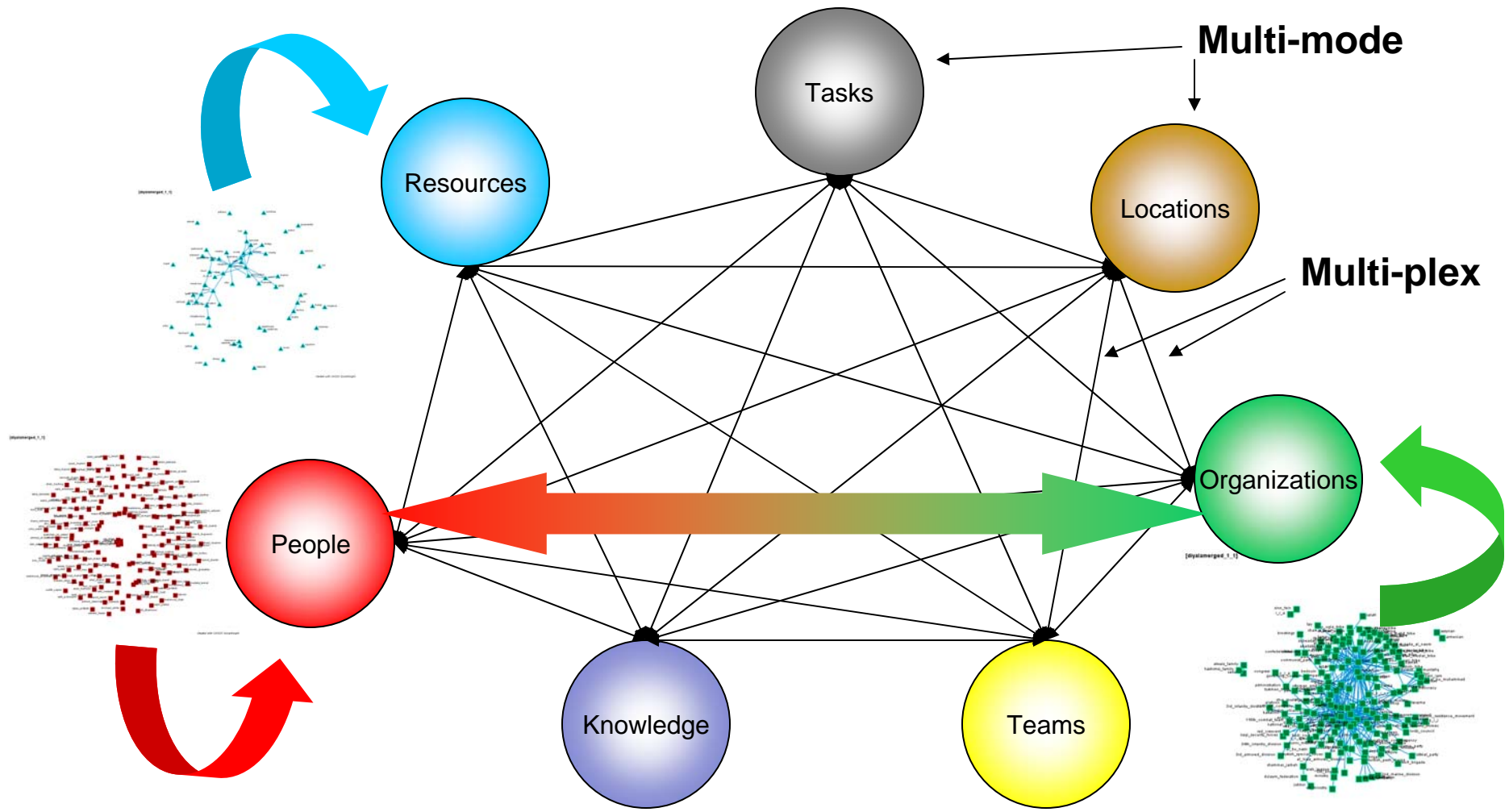
- Collaboration with Army Partners
- Stress Effects
- High Speed Computing
- University & Industry Partners
- In-house Acceleration
- Customer Transition
- Business Link
- Basic Science Transition
- International
- Scientific Forum

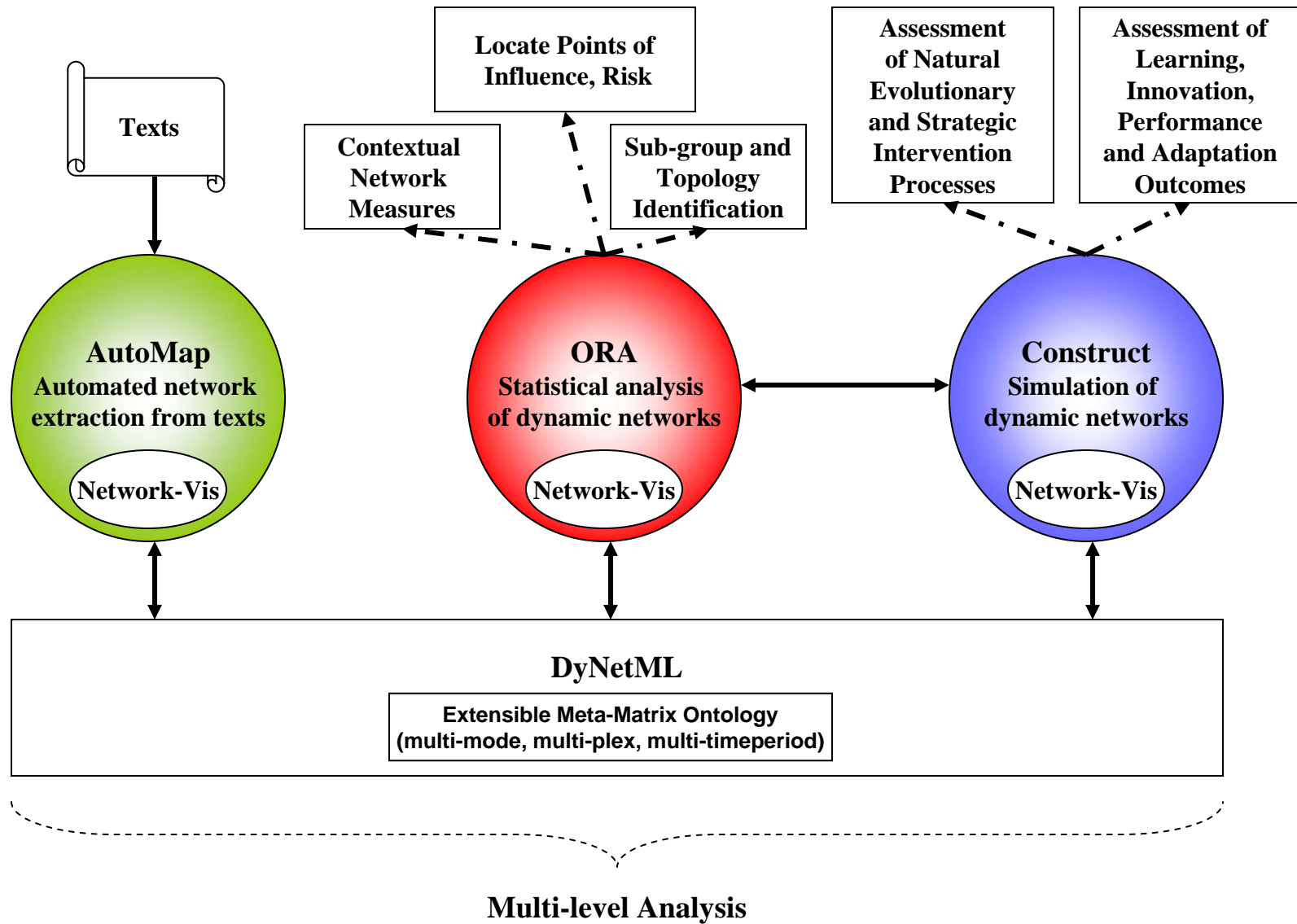
- **Strategic Research Objective (SRO): Enhancing Soldier Performance**



- **MURI: Optimizing Cognitive Readiness under Combat**
- **Cooperative R&D Agreements**
 - MINDSS program & University of Maryland
- **Collaborative Technology Alliances**
 - Advanced Decision Architectures & Robotics – New ITA
- **Director's Research Initiative (DRI)**
- **Customer Funding**
 - Survivability, Lethality, and Analysis Directorate, Recognition-Primed Decision Making Modeling
- **Small Business Innovative Research (SBIR) contracts**
- **Advanced Technology Objectives**
- **NATO panel on Human Beh Rep; DEAs; TTCPs**
- **Conference on Behavior Rep in M&S (BRIMS)**

Dynamic Network Analysis: Interacting Dynamic Networks





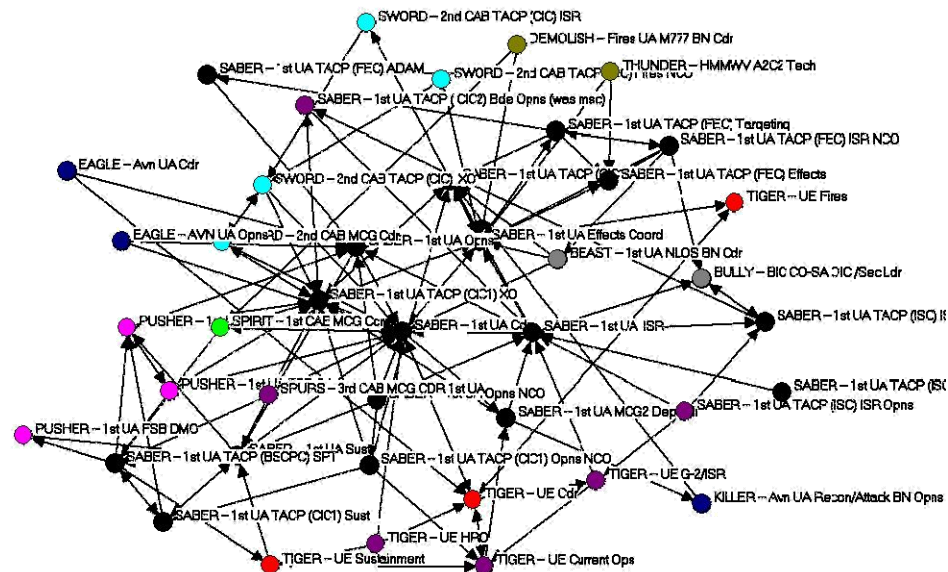
Battle Command Group

CPOF Analysis of the Network-Centric Organization

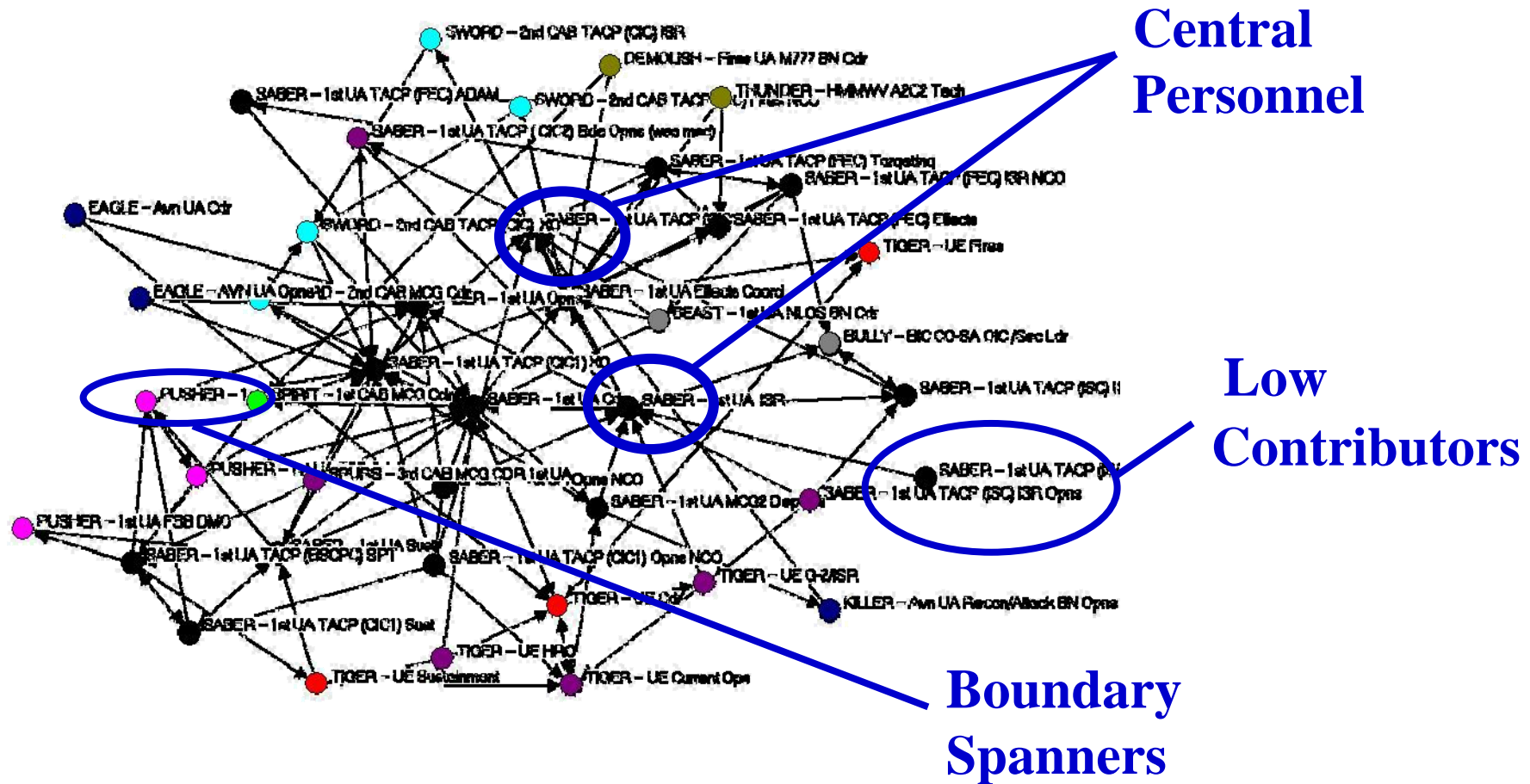
1st Cavalry Division (Field)



UEx (Laboratory)



Exposing Network-Centric Social Structure

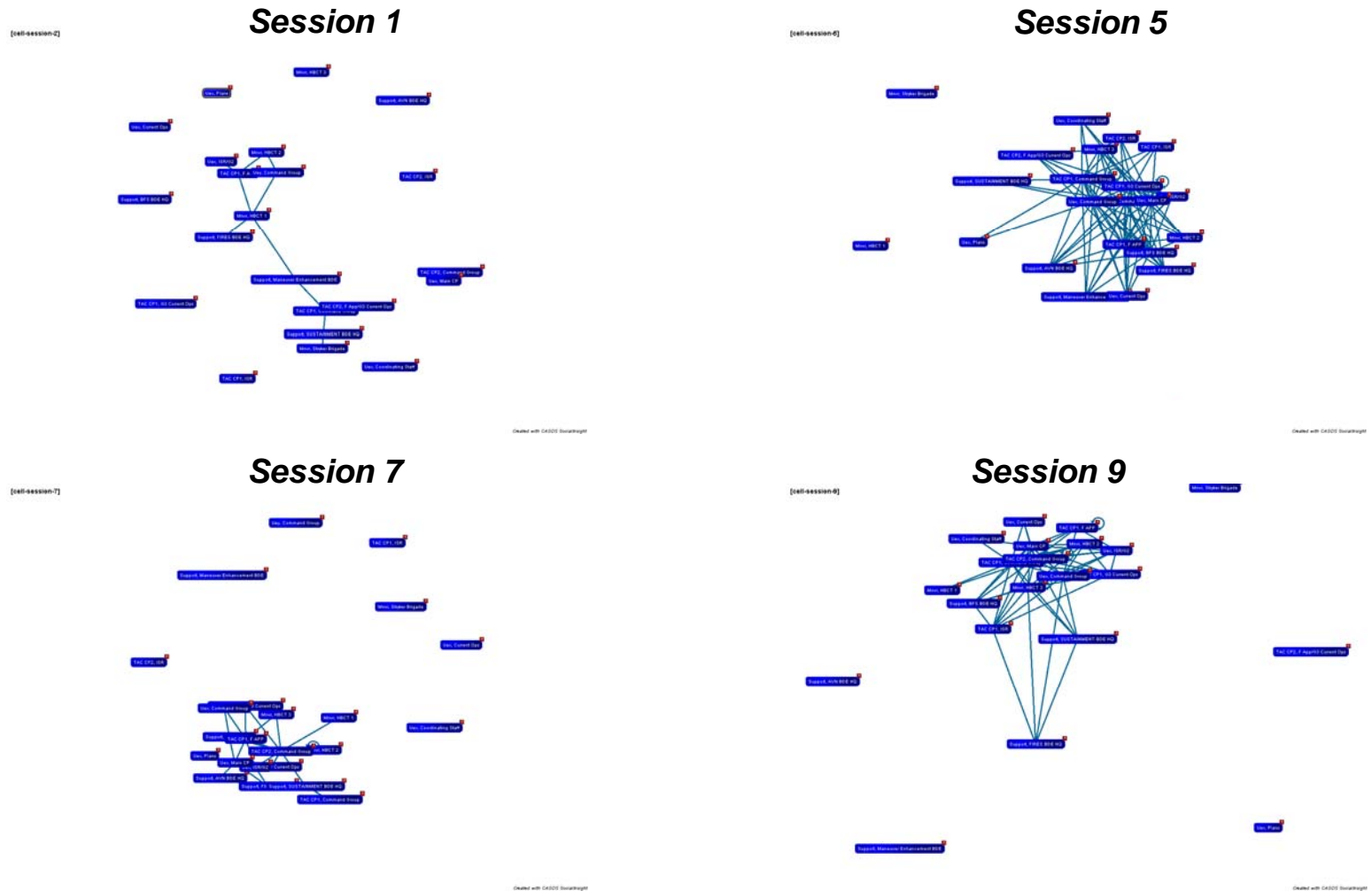


Communication Network

Shared Situational Awareness

- Important to maintain a common understanding of the situation
 - Rapidly changing environment; uncertainty
 - Decentralized, distributed and interdependent units
 - Joint and coalition operations
 - Combat and non-combat responsibilities
- Shared SA was measured by similarity in perceived risk to the operation.

Unit Level - High Shared SA



Takeaway

- Social Context matters
 - Networks enable and constrain behavior/decisions
 - Who you talk to
 - What tasks you perform
 - SA and SSA are dynamic
 - Environmental/Organizational stress
- Integrating SA research (cellular and social)
 - How is SA developed for a variety contexts?
 - Multi-tasking
 - Operational requirements
 - How does SA develop dynamically?
- Application
 - Training requirements
 - Information technology requirements

LSA

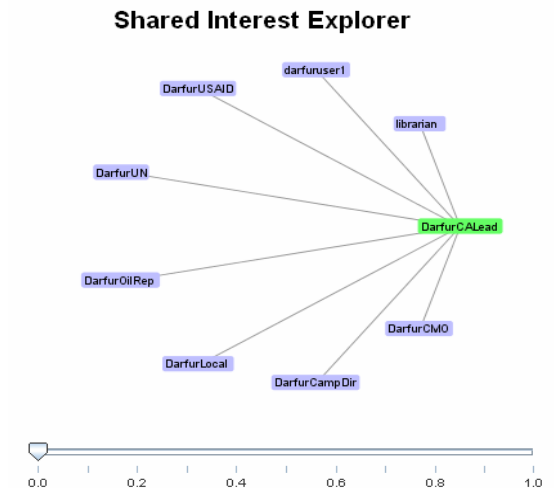
Essentials of Latent Semantic Analysis

Communication Analysis

- **Goal: Automatically monitor and analyze communication streams to better understand team performance and process**
- **Improve collaboration within and between organizations and cultures**
- **Approach**
 - **Provide tools to monitor communication content and patterns of interaction**
 - **Automatically relate communication analysis measures to:**
 - **Performance**
 - **Situation Awareness**
 - **Consensus**
 - **Shared Interest**
 - **etc.**

Coalition Metrics

- **Contributions**
 - Participation
 - Amount of content
- **Communication network**
 - Social network analysis: Who's talking to whom
 - Changes over time in communication patterns
- **Shared interest**
 - Similarity between team members' comments
 - Are members of other groups discussing the same things as your group
- **Topical consensus**
 - Is everyone discussing the same or different things
 - Evidence of “groupthink”



Participation Analysis: Email, Chat & VOIP

More communication in collaborative technology assisted Run 2.

	Run 1	Run 2
Messages	3187	4499



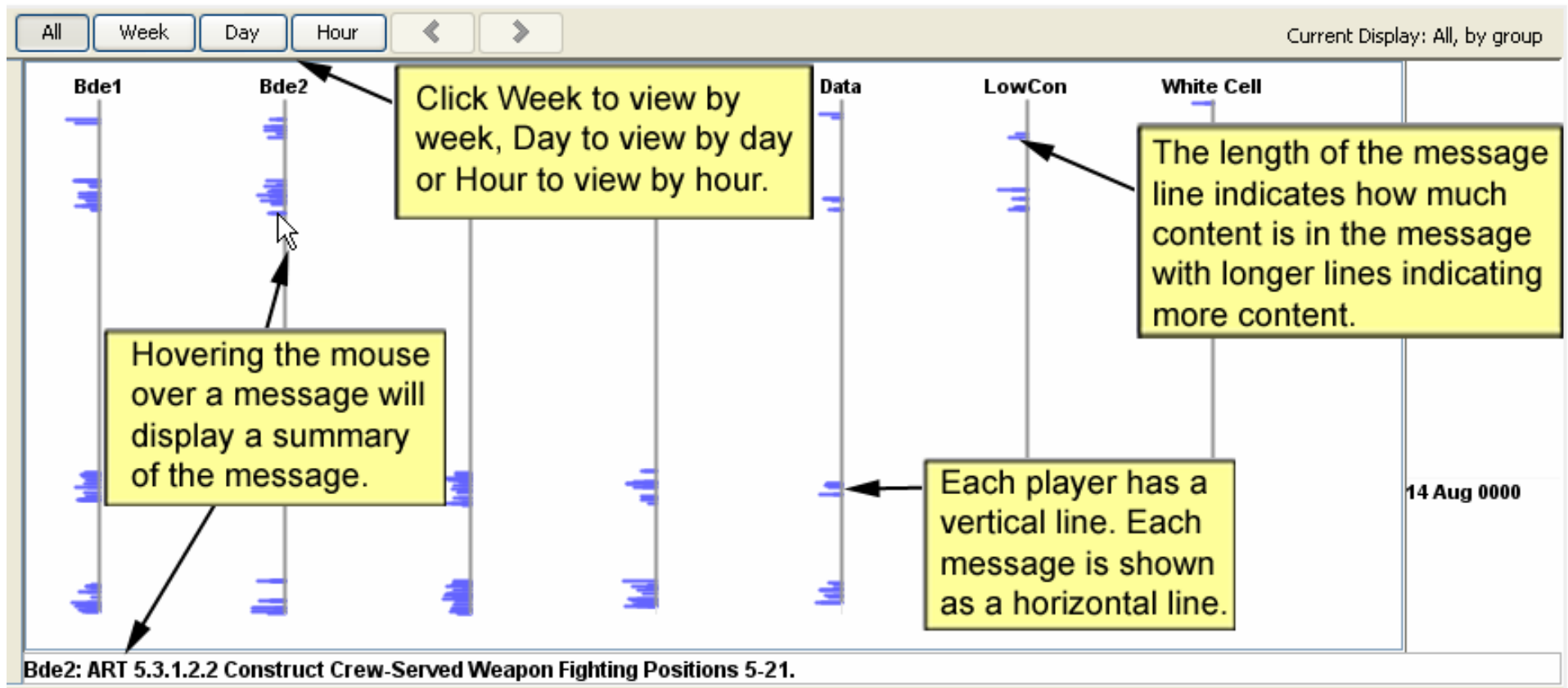
	Run 1	Run 2
CTF Comd	80%	66%
CTF Deputy Comd	20%	34%

CTF commander did not delegate to his deputy in Run 1, but in Run 2 the CTF commander used his deputy to help coordinate planning.

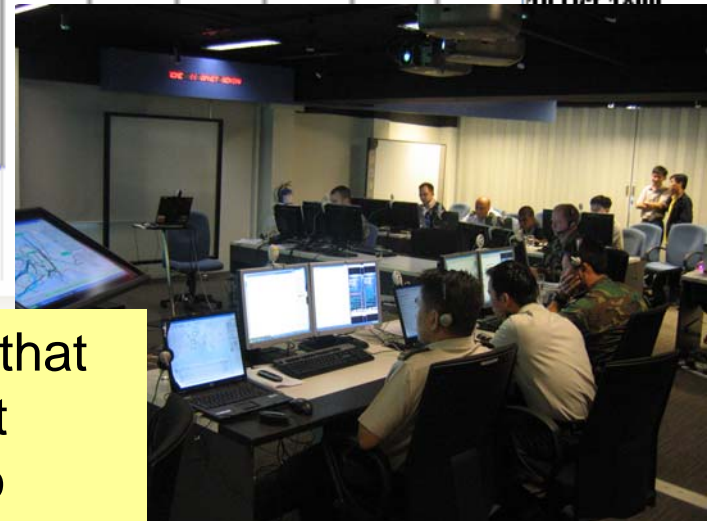
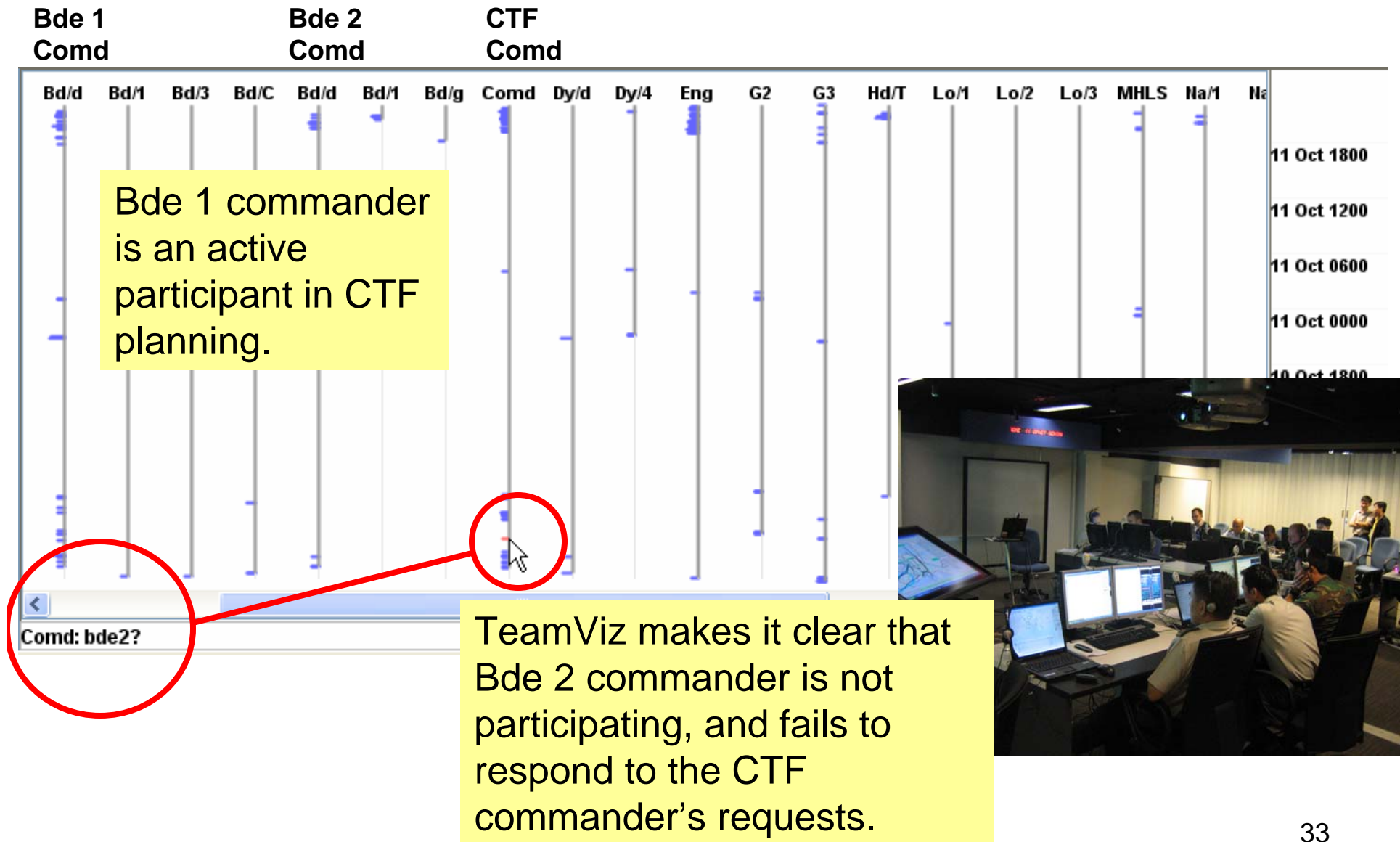
Bde 1 Commander was more active than Bde 2 Commander in both runs.

	Run 1	Run 2
Bde 1 Comd	62%	78%
Bde 2 Comd	38%	22%

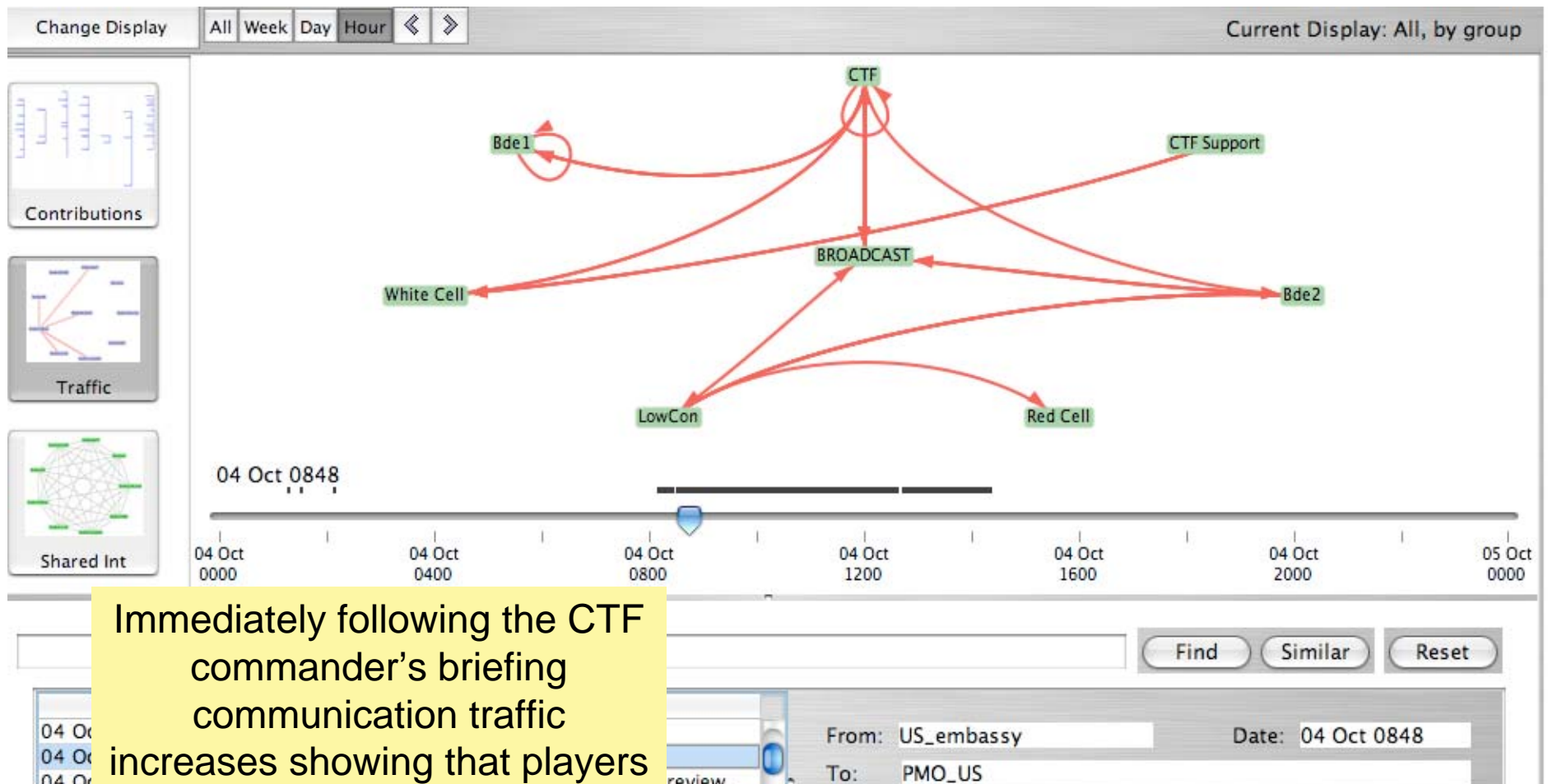
Team Viz: Contributions



Run 2: CTF Communication Patterns



Visualization: Traffic Patterns



How to Influence

- For the target
 - Who are they connected to
 - What groups are they in
 - What do they know
 - What resources do they control
 - What activities are they involved in

Attribute	Score	Ranking
Interacts with	1	Low
Knowledge areas	10	High
Resource areas	7	High
Organizations associated with	17	High
Density of ego net	.097	High
Task exclusivity	.0226	High
Resource exclusivity	.010	High
Knowledge exclusivity	.0254	High
Degree Centrality	.017	Norm
Betweenness	.0024	High
Cognitive Demand	.033	High
Eigenvector Centrality	.001	Low

